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STILL LOOKING FOR LOST PROFITS: THE CASE OF HORIZONTAL COMPETITION

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Abstract: When infringement of a patent dissipates profit relative to the licensing agreement that would otherwise occur, damages under the lost-profit rule deter infringement, and otherwise not. We develop this point in a general model and give two examples. However, joint profit might not be dissipated by infringement. An important example is where there are restrictions on licensing that arise from competition policy.

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1 Introduction

Damage awards in litigation have two economic purposes: to deter incursions into someone's rights, or to compensate the damaged party afterwards. If compensatory awards are large enough to deter the incursion in the first place, then the two objectives are congruent.

In the case of patent damages, which is our focus here, there have been two damage rules: lost profit and unjust enrichment (disgorgement). The prevailing rule in the U.S. is lost profit, although prior to the patent reform in 1946, the unjust enrichment doctrine was widely used by courts. See our previous paper (2001), Anton and Yao (2005), or Blair and Cotter (2005) for discussions of these rules in the U.S. See Reitzig et al (2002) for a discussion of which rules apply in the international arena.

Lost profit seems directed at compensating the rightholder rather than deterring the infringer, while disgorgement seems directed at deterring the infringer rather than compensating the rightholder. Nevertheless, as we have argued in our previous paper (2001), both rules may deter infringement, and then the issue of compensation does not arise.

Our 2001 paper introduced an equilibrium perspective: when it is efficient to share the intellectual property, licensing should occur in equilibrium, and lost profit should be evaluated with respect to the licensing outcome that should have occurred. A difficult case, however, is that of horizontal competition, where the patent holder should both produce and license in equilibrium. The economic notion of lost profit should include losses from both licensing and production for the market. We concluded that when infringement leads to dissipation of profit, the lost-profit rule deters infringement.

Anton and Yao (2005) have revisited this issue, showing that our conclusions can be reversed. In their model of Cournot competition, infringement in equilibrium is not only possible, but inevitable, and does not dissipate profit.

Here we unify our previous results and the Anton/Yao point of view in a single theory, giving a simple abstract argument that profit dissipation is, in fact, definitive. We show that if infringement dissipates joint profit, infringement is deterred under the lost-profit rule, and otherwise not. The demonstration we provide is not tied to any particular model, or to any particular assumptions about the timing or form of competition. In particular, it is not tied to the models of our previous paper or to the model of Anton and Yao. However, we use those models as examples.

Profit dissipation is defined as a comparison with a counterfactual that would have occurred, absent the infringement. We argue that the natural counterfactual is that which would be optimal (profit-maximizing) for the two firms, which will often involve licensing. This perspective leads to a different interpretation of Anton’s and Yao’s example than they give. They assume that there would be no licensing in the absence of infringement, and argue that the key to their result is that the rival can avoid paying damages by “passive infringement.” Passive infringement means that the rival supplies the same quantity when infringing as when not infringing. Then the patent holder loses nothing by the infringement, but the infringer saves costs. This makes passive infringement a dominant strategy. However, we show in example 2 that infringement may occur *even if* the counterfactual involves (legal) licensing, and even if lost profit accounts for the lost licensing revenue as well as lost revenue from sales. This is because joint profit is nevertheless higher with infringement than without, which we view as the key point.

In section 2 we develop the link between profit dissipation and deterrence under the lost-profit rule. In section 3 we argue that the counterfactual for calculating lost profits should logically consider both lost licensing revenues and lost revenue in the market. We also comment on deterrence under the unjust-enrichment rule, and how it also depends on the counterfactual. In section 4 we suggest that, if infringement increases joint profit instead of dissipating profit, it is because the damage rule leads to market coordination that would be deemed illegal if achieved by license. In this sense, the damage rule may be “collusive.”

2 Deterrence and Profit Dissipation under the Lost-Profit Rule

Suppose that a patentholder named p and rival named r jointly serve a market. For the case that there is no infringement of the patent, represent the payoffs in the market by functions π_p, π_r of the quantities supplied, q_p, q_r . The payoffs $\pi_p(q_p, q_r), \pi_r(q_p, q_r)$ might reflect, for example, a licensing arrangement with royalties. Let (q_p^*, q_r^*) be the Nash equilibrium of the game played with no infringement and payoff functions π_p, π_r . Let $\pi_p^* = \pi_p(q_p^*, q_r^*)$. (This value will be a parameter of the damages function, δ below.)

For the game played in case of infringement, the payoff functions are $\tilde{\pi}_p + \gamma\delta$ and $\tilde{\pi}_r - \gamma\delta$ for the two parties respectively, which are also functions of quantities supplied, q_p, q_r . The parameter γ is the probability of being held liable for infringement, and δ represents a

damage payment. Thus, the part of the payoff function represented by $\gamma\delta$ is the expected damage paid from r to p , and the part represented by $\tilde{\pi}_p, \tilde{\pi}_r$ represents profits in the market. Let $(\tilde{q}_p, \tilde{q}_r)$ be the Nash equilibrium of the game played with infringement and with payoff functions $\tilde{\pi}_p + \gamma\delta, \tilde{\pi}_r - \gamma\delta$.

Say that damages are *lost-profits damages* if

$$\delta(q_p, q_r; \pi_p^*) = \max[\pi_p^* - \tilde{\pi}_p(q_p, q_r), 0] \quad (1)$$

Say that *infringement is deterred at γ* if (2) holds, and otherwise say that infringement is not deterred.

$$\gamma\delta(\tilde{q}_p, \tilde{q}_r; \pi_p^*) \geq \tilde{\pi}_r(\tilde{q}_p, \tilde{q}_r) - \pi_r(q_p^*, q_r^*) \quad (2)$$

Say that *infringement dissipates joint profit* if (3) holds, and otherwise we say that infringement does not dissipate joint profit.

$$\pi_p(q_p^*, q_r^*) + \pi_r(q_p^*, q_r^*) \geq \tilde{\pi}_p(\tilde{q}_p, \tilde{q}_r) + \tilde{\pi}_r(\tilde{q}_p, \tilde{q}_r) \quad (3)$$

Since the damages δ are a transfer from one firm to the other, condition (3) would typically be interpreted to mean that infringement increases competition between the firms.

The inequalities give us directly the following propositions. Proposition 1(a) is the abstraction behind the analysis in our previous (2001) paper. Proposition 2 is the abstraction behind the conclusions of Anton and Yao (2005).

Proposition 1 *If infringement dissipates joint profit (i.e., if (3) holds), and if infringement results in damages equal to lost profits (i.e., if (1) holds), then infringement is deterred in equilibrium ((2) holds) if*

$$(a) \quad \pi_p(q_p^*, q_r^*) - \tilde{\pi}_p(\tilde{q}_p, \tilde{q}_r) > 0 \text{ and } \gamma \geq \frac{\tilde{\pi}_r(\tilde{q}_p, \tilde{q}_r) - \pi_r(q_p^*, q_r^*)}{\pi_p(q_p^*, q_r^*) - \tilde{\pi}_p(\tilde{q}_p, \tilde{q}_r)}, \text{ or}$$

$$(b) \quad \pi_p(q_p^*, q_r^*) - \tilde{\pi}_p(\tilde{q}_p, \tilde{q}_r) \leq 0.$$

Proposition 2 *If infringement does not dissipate joint profit (i.e., (3) does not hold) and infringement results in damages equal to lost profit (i.e., if (1) holds), and if $\pi_p(q_p^*, q_r^*) - \tilde{\pi}_p(\tilde{q}_p, \tilde{q}_r) \geq 0$, then infringement is not deterred in equilibrium at any $\gamma \leq 1$ (i.e., (2) does not hold).*

Proposition 1(b) is included for completeness, although it is hard to think of examples. The circumstance described is that infringement increases the market revenue of the patentholder and, since (3) holds, decreases the market revenue of the infringer.

There is an asymmetry in these propositions with respect to γ . Proposition 1(a) only claims that infringement is deterred provided the probability of detection is high enough. (The condition includes $\gamma = 1$.) However, Proposition 2 says that, if infringement does not dissipate joint profit (and if the infringement does not work to the benefit of the patent holder), infringement is not deterred regardless of the probability of detection.

Perhaps the most important consequence of Proposition 1(a) is the following:

Corollary 1 *If licensing increases the (noninfringement) profit of both parties, infringement may be deterred in equilibrium if the counterfactual involves licensing, but not otherwise.*

With licensing, the joint profit in the absence of infringement is higher, so Proposition 1 is more likely to apply than Proposition 2. Stated in practical terms, if the court is accounting for lost licensing revenues, it will hand out higher damages, and the prospect of higher damages will more likely deter infringement.

If the firms get to the game with infringement, it is because they never played the game without infringement, which becomes a counterfactual that the court must guess in order to establish damages. This is probably the most important thing buried in the propositions. Establishing the counterfactual is especially vexing if the counterfactual would logically involve licensing. According to the Corollary, if the court ignores licensing, it is likely to hand out lower damages, and infringement is less likely deterred. Nevertheless, using a counterfactual that involves licensing will not always deter infringement, as shown by example 2 below.

Example 1 illustrates Proposition 1(a). We contemplate a patented product for which the marginal cost of production is increasing, and assume that a license between the patent holder and a second supplier lowers the cost of production. As compared to the optimal licensing arrangement, infringement would lead to an increase in supply and smaller joint profit, due to competition between the two firms. If infringement would be detected with probability one, the second supplier is better off with a license than with infringement. Since he pays the patent holder's lost profits in case of infringement, his own profit gain is the difference in joint profit with and without infringement, which is negative.

Example 2 illustrates Proposition 2. We revisit the cost-reducing innovation studied by Anton and Yao, but assume that, absent the infringement, the patent holder would license

to the rival at a royalty equal to the cost advantage. Such a license would lead to the same market price as if the rival produced with the higher-cost technology, but it would yield higher profit for the patent holder. Since the counterfactual to infringement is licensing, the infringer cannot avoid damages by “passive infringement.”

Nevertheless, just as in the analysis of Anton and Yao, there will be infringement in equilibrium. Our explanation, in line with Proposition 2, is that the infringement increases joint profit. This is because the infringer reduces his supply relative to what he would supply under license. By reducing supply, the infringer mitigates the patent holder’s loss, and thus mitigates the damages he must pay. In essence, the damage rule facilitates collusion.

Example 1: Licensing a Product for Productive Efficiency

Suppose the patentholder p has a patent on a new product, and $\rho(q_p + q_r)$ is the demand price when the total supply of both firms is $(q_p + q_r)$. If the patent holder supplies the market as a monopolist, his profit is $\pi^M = \max_q q [\rho(q) - c(q)]$, where the cost function $c(\cdot)$ is positive, increasing, strictly convex and $c(0) = 0$. Because marginal cost is increasing, it is efficient to divide production with a licensee. Assume that a license divides production in half,³ and the total production achieves $\pi^J = \max_q q [\rho(q) - c(\frac{q}{2})]$ which is larger than π^M . With licensing for efficient production, each firm produces half the efficient output, say $q^*/2$, and the profits are shared by p and r according to $\pi_p(q_p^*, q_r^*) + \pi_r(q_p^*, q_r^*) = \pi^J$.

Suppose now that the second firm infringes and competes with the patent holder in the market. With infringement, the patent holder’s and infringer’s payoff functions are

$$\begin{aligned} \tilde{\pi}_p(q_p, q_r) + \gamma\delta(q_p, q_r; \pi_p^*) & : = [\rho(q_p + q_r)q_p - c(q_p)] + \gamma\delta(q_p, q_r; \pi_p^*) \\ \tilde{\pi}_r(q_p, q_r) - \gamma\delta(q_p, q_r; \pi_p^*) & : = [\rho(q_p + q_r)q_r - c(q_r)] - \gamma\delta(q_p, q_r; \pi_p^*) \end{aligned}$$

Suppose that $\gamma = 1$, so that detection is assured after some period. Then the payoff functions with infringement can be written

$$\begin{aligned} \tilde{\pi}_p(q_p, q_r) + \delta(q_p, q_r; \pi_p^*) & = \tilde{\pi}_p(q_p, q_r) + \max\{\pi_p^* - \tilde{\pi}_p(q_p, q_r), 0\} \\ & = \max[\pi_p^*, \tilde{\pi}_p(q_p, q_r)] \\ \tilde{\pi}_r(q_p, q_r) - \delta(q_p, q_r; \pi_p^*) & = \tilde{\pi}_r(q_p, q_r) - \max\{\pi_p^* - \tilde{\pi}_p(q_p, q_r), 0\} \\ & = \min\{[\tilde{\pi}_r(q_p, q_r) + \tilde{\pi}_p(q_p, q_r)] - \pi_p^*, \tilde{\pi}_r(q_p, q_r)\} \end{aligned} \tag{4}$$

³This typically requires some term of license other than royalties; see Maurer and Scotchmer (2004).

Consider two cases. First suppose total profit is the same with and without infringement. This requires that $(\tilde{q}_p, \tilde{q}_r) = (q^*/2, q^*/2)$ so $\tilde{\pi}_p\left(\frac{q^*}{2}, \frac{q^*}{2}\right) + \tilde{\pi}_r\left(\frac{q^*}{2}, \frac{q^*}{2}\right) = \pi^J$. By symmetry in the case of infringement, each firm gets $(1/2)\pi^J$. If $\pi_p^* \geq (1/2)\pi^J = \tilde{\pi}_p\left(\frac{q^*}{2}, \frac{q^*}{2}\right)$, then damages are positive and infringement is (weakly) deterred, since

$$\delta\left(\frac{q^*}{2}, \frac{q^*}{2}; \pi_p^*\right) = \pi_p^* - \tilde{\pi}_p\left(\frac{q^*}{2}, \frac{q^*}{2}\right) \geq \pi_p^* - \frac{1}{2}\pi^J \geq 0$$

and

$$\begin{aligned} \tilde{\pi}_r\left(\frac{q^*}{2}, \frac{q^*}{2}\right) - \delta\left(\frac{q^*}{2}, \frac{q^*}{2}; \pi_p^*\right) &\leq \frac{1}{2}\pi^J - \left[\pi_p^* - \frac{1}{2}\pi^J\right] \\ &= \pi^J - \pi_p^* = \pi_r(q_p^*, q_r^*) \end{aligned}$$

Suppose instead that $\pi_p^* < (1/2)\pi^J = \tilde{\pi}_p(q^*/2, q^*/2)$. Then the patentholder is better off with infringement, so damages are zero and infringement is deterred because

$$\tilde{\pi}_r\left(\frac{q^*}{2}, \frac{q^*}{2}\right) - \delta\left(\frac{q^*}{2}, \frac{q^*}{2}; \pi_p^*\right) = \frac{1}{2}\pi^J < \pi_r(q_p^*, q_r^*)$$

Second, suppose total profit is smaller with infringement. This would occur if $(\tilde{q}_p, \tilde{q}_r) \neq (q^*/2, q^*/2)$, so that $\tilde{\pi}_p(\tilde{q}_p, \tilde{q}_r) + \tilde{\pi}_r(\tilde{q}_p, \tilde{q}_r) < \pi^J$. Then

$$\begin{aligned} \tilde{\pi}_r(\tilde{q}_p, \tilde{q}_r) - \delta(\tilde{q}_p, \tilde{q}_r; \pi_p^*) &\leq \tilde{\pi}_r(\tilde{q}_p, \tilde{q}_r) + \tilde{\pi}_p(\tilde{q}_p, \tilde{q}_r) - \pi_p^* \\ &< \pi^J - \pi_p^* = \pi_r(q_p^*, q_r^*) \end{aligned}$$

so infringement is deterred.

Example 2: Cost Reductions (Anton and Yao, 2005, revised)

The patentholder p and rival r compete in a market with constant, but possibly different, marginal costs. The market demand price is given by $\rho(q) = 1 - q$, where q is total output in the market. Before the innovation, both firms have high marginal cost \bar{c} , and after p innovates, p has marginal cost $c < \bar{c}$. For simplicity we will use numbers. Let $c = 0$ and $\bar{c} = 0.137$. We assume the patent holder licenses the rival at royalty

$$\ell = \bar{c} - c = 0.137$$

The license puts the rival in the same market position as if he used the old technology, but is more profitable for the patent holder. The profit functions of the innovators are then

$$\begin{aligned} \pi^p(q_p, q_r) &= \rho(q_p + q_r) q_p + \ell q_r \\ \pi^r(q_p, q_r) &= (\rho(q_p + q_r) - \ell) q_r \end{aligned}$$

The Nash equilibrium of this game is $(q_p^*, q_r^*) = (0.379, 0.242)$ and profits satisfy

$$\pi_p(q_p^*, q_r^*) = .1764, \quad \pi_r(q_p^*, q_r^*) = .058$$

However, this Nash outcome will not be achieved in equilibrium because of infringement.

Infringement will increase total profit, with the surplus collected by the rival.

The Nash equilibrium of the game with infringement is defined by payoff functions

$$\begin{aligned} \tilde{\pi}_p(q_p, q_r) + \gamma \delta(q_p, q_r; \pi_p^*) &= \tilde{\pi}_p(q_p, q_r) + \gamma \max\{\pi_p^* - \tilde{\pi}_p(q_p, q_r), 0\} \\ \tilde{\pi}_r(q_p, q_r) - \gamma \delta(q_p, q_r; \pi_p^*) &= \tilde{\pi}_r(q_p, q_r) - \gamma \max\{\pi_p^* - \tilde{\pi}_p(q_p, q_r), 0\} \end{aligned}$$

where $\tilde{\pi}_r(q_p, q_r) = q_r \rho(q_p + q_r)$ and $\tilde{\pi}_p(q_p, q_r) = q_p \rho(q_p + q_r)$. If $\gamma < 1$, the patentholder maximizes either $\tilde{\pi}_p(q_p, q_r)$ or $(1 - \gamma) \tilde{\pi}_p(q_p, q_r)$. These lead to the same strategy. If $\gamma = 1$, the payoff functions are.

$$\begin{aligned} \tilde{\pi}_p(q_p, q_r) + \delta(q_p, q_r; \pi_p^*) &= \max\{\pi_p^*, \tilde{\pi}_p(q_p, q_r)\} \\ \tilde{\pi}_r(q_p, q_r) - \delta(q_p, q_r; \pi_p^*) &= \min\{[\tilde{\pi}_r(q_p, q_r) + \tilde{\pi}_p(q_p, q_r)] - \pi_p^*, \tilde{\pi}_r(q_p, q_r)\} \end{aligned}$$

For γ close to 1, we claim that $(\tilde{q}_p, \tilde{q}_r) = (0.42, 0.16)$ is an equilibrium with infringement.⁴ Total output is lower, while the price and the infringer's profit are higher than without infringement. The profits with infringement are

$$\tilde{\pi}_p(\tilde{q}_p, \tilde{q}_r) = .1764, \quad \tilde{\pi}_r(\tilde{q}_p, \tilde{q}_r) = .0672$$

The patentholder is optimizing even if γ is slightly less than one, since

$$\frac{\partial}{\partial q_p} \tilde{\pi}_p(\tilde{q}_p, \tilde{q}_r) = 1 - q_r - 2q_p = 0$$

The rival is also optimizing. If he increases his output to $q_r > \tilde{q}_r$, the price will fall, and the patent holder will then earn $\tilde{\pi}_p(\tilde{q}_p, q_r) < \tilde{\pi}_p(\tilde{q}_p, \tilde{q}_r)$. This fall in the patent holder's profit must be paid in damages. Total profit also falls because total output is already larger than the monopoly output. Therefore, even though the increase in q_r increases the rival's profit, the increase does not outweigh the damages that must be paid to the patent holder.

Thus, it is not optimal to increase q_r . Suppose instead that the rival decreases q_r . Then the

⁴We wish to study the Nash Equilibrium at $\gamma = 1$. Instead we assume that γ is "close to" 1 so the patent holder is not indifferent among all his strategies (outputs); instead he chooses q_p to maximize $\tilde{\pi}_p(q_p, q_r)$ even if $\pi_p^* > \tilde{\pi}_p(q_p, q_r)$. The rival's strategy is continuous in γ , so his optimizing strategy is essentially the same at γ slightly less than one as at $\gamma = 1$.

market price rises, which causes the patent holder’s profit to rise, so the rival is still in the position of not paying damages. However, decreasing output decreases the rival’s profit, since

$$\frac{\partial}{\partial q_r} \tilde{\pi}_r(\tilde{q}_p, \tilde{q}_r) = 1 - q_p - 2q_r = 0.26 > 0$$

Thus, the result of Anton and Yao is not overturned even when the firms license to share the cost-reducing innovation. Even though the benchmark profit with licensing, π_p^* , is greater than without licensing, infringement still increases total profit. Thus, infringement will occur in equilibrium.

3 Deterrence and the Counterfactual

As we pointed out above, the game played between the rival and patent holder in the absence of infringement depends on whether they license. At the stage of infringement, the game is an hypothesis rather than something observable. If the court hypothesizes that the firms would otherwise have licensed, the court may award higher damages than otherwise, which expands the set of market circumstances in which infringement is deterred.

In their discussion of cost-reducing innovations, Anton and Yao assumed that the counterfactual does not involve licensing, even though licensing could increase the profits of both parties. They concluded that infringement is not deterred. As we argued in example 2, the counterfactual with licensing may also lead to infringement. But in situations like example 1, the two counterfactuals may give different results, since the potential infringer may predict substantially different damages.

We view licensing as the right counterfactual when it improves efficiency and increases profit. This is mainly because an “equilibrium” analysis should assume optimizing behavior. It is not very convincing to predict infringement if the assumed alternative is nonoptimal for both parties, and the assumed alternative therefore leads to low damage awards. We admit, however, that much of U.S. practice is to award damages equal to market losses or lost royalties, but often not both. If the potential infringer realizes that the court will focus on one or the other, damages may be so low that infringement is not deterred.

Since the lost-profit rule has not emerged as a reliable deterrent to infringement even with a full accounting for lost profit, it is worth asking whether the unjust-enrichment rule does better, and whether the answer also depends on the counterfactual. Just as

with the lost-profit rule, there is a question of how to calculate the benchmark profits. For unjust enrichment, it is the infringer's benchmark profit rather than the licensor's benchmark profit that we must assess. Three possibilities for how to interpret unjust enrichment are (1) infringer's profit (with infringement), (2) infringer's profit, net of his profit using nonproprietary technology, or (3) infringer's profit, net of his profit in the licensing arrangement that should otherwise have occurred. As with our lost-profit rule, the benchmark (3) is particularly difficult to assess, and we know of no case law that suggests it. For case law supporting (1) and (2), see the discussion in our (2001) paper and in Blair and Cotter (2005).

With the unjust-enrichment rule, damage awards are larger (no smaller) under (1) than under (2) and (3), and therefore more reliable in deterring infringement. This contrasts with the Corollary above for the lost-profit rule, where we claim that deterrence is enhanced by accounting for lost licensing revenue.

4 Infringement and Competition Policy

Finally, we comment on the interesting fact that infringement can increase joint profit. If the firms can limit competition and increase joint profit through infringement, why not through license? If they could achieve the same ends through license, then infringement would be deterred, by Proposition 1.

Our answer to this, suggested above, is that the damage rule facilitates market behavior that would be deemed an antitrust violation if achieved through license. The license allowed in example 2 above is very limited. Suppose instead that the license could support the monopoly price. Then the firms would earn more joint profit than with infringement, and infringement would be deterred.

However, most commentators (e.g., Kaplow 1984) would take the view that the maximum allowable royalty in the case of a cost reduction should be $\ell = \bar{c} - c$, as we assumed. Such a royalty allows the inventor to capture the social value (cost reduction) provided by the invention, but not more. If a higher royalty could be enforced (for example, by agreeing that the licensee pays the royalty even if he reverts to the old technology), the higher royalty could arguably be deemed collusive. This view would accord, for example, with the *derived reward* principle articulated by Maurer and Scotchmer (2004), under which all of the profit earned by the inventor must derive from the value of the invention. If the royalty were

higher than $\ell = \bar{c} - c$, the resulting profit would arguably derive from collusion, and not from the value of the invention, and hence be deemed anticompetitive.

This line of reasoning brings us to an odd conclusion, namely, that the lost-profit damage rule can be “collusive.” For the cost-reducing innovation, competition between the patent holder and the infringer is muted because the infringer wants to mitigate the patent holder’s losses. He does this by reducing output to bolster the market price. The damage rule thus operates like a commitment device to soften competition, even though such a commitment may be illegal if accomplished through license.

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